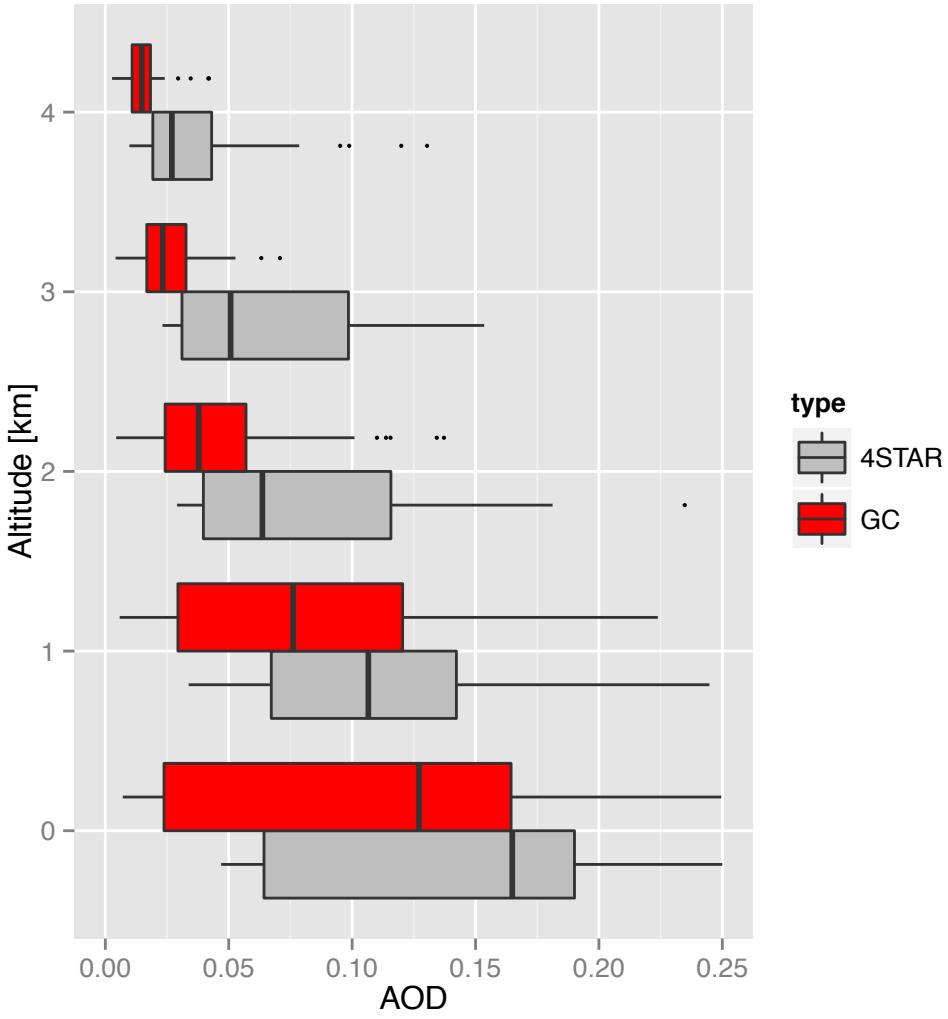
We thank the anonymous reviewer for their helpful comments – we have made changes to the manuscript in response to their suggestions outlined in red below.

This paper describes the aerosol characteristics as simulated by the GEOS-Chem model during the NASA SEAC4RS field campaign in 2013. The paper presents comparisons of the aerosol measurements acquired by the NASA DC-8 aircraft and compares the GEOS-Chem simulations with these measurements. Overall the paper provides a very good description of the GEOS-Chem simulations and these comparisons. However, there are a couple of major items the authors need to address before publication. I recommend the authors address these items before publication.

Major 1. The discussion regarding AOD comparisons is confusing. Looking at Figure 10, it looks like the model significantly underestimates AOD relative to MODIS. The MISR comparison looks better but the model still seems to underestimate AOD. The discussion seems to indicate that the GEOS-Chem AOD underestimate is consistent with the aerosol extinction estimate but Figure 9 does not seem to show the same underestimate in aerosol extinction as in AOD. What is the underestimate in extinction relative to both HSRL and the CRDS? Also, why not compare the GEOS-Chem model AOD with the AERONET measurements during the diurnal cycle in at least a few locations? If there is some question as to the ability of the model to represent AOD, it would be good to make some more detailed measurements of AOD with AERONET at various times of the day and a few locations. Also, the DC-8 also deployed the 4STAR instrument, which measured column AOD at many wavelengths; this may help provide additional data for layer AOD comparisons.

Please also see the response to Comment #2 from Reviewer #1. Additional quantification of the model low bias has been added into the text (a low bias of 14.7% relative to CRDS and 16.4% relative to HSRL; 8% low bias relative to MISR; 28% low bias relative to MODIS). Our ability to compare to the AERONET diurnal cycle (i.e. the AOD during the sunlit portion of the day) is limited by the lack of necessary output from the high-resolution simulation results. We will include the 4STAR comparisons, reproduced in the vertical profile shown below at 550 nm (the wavelength of the GEOS-Chem AOD output), in the Supplementary Material. These are the good retrievals (marked with quality flag = 0), which show the above plane AOD. The column low bias (19.1%), taken as the low bias in the lowest 1-km layer, is similar to the low biases discussed previously. The choice of scale truncates some very large observations.



2. There should be more discussion regarding ML heights related to the model. How does the GEOS-Chem derive ML heights? From Richardson number? Aerosol gradients? If the mechanism is different from the lidar measurements, one may expect to see differences depending on location and time of day. Why were the GEOS-Chem heights 30-50% too high before adjustment? What was done to the model to reduce this bias? Does this imply that the model requires external information to constrain the PBL height to satisfactorily estimate PM2.5? How would the GEOS-Chem results been different if these external measurements of PBL height not been available?

Additional discussion of ML heights, how they are defined, and the impact of the ML height adjustment on $PM_{2.5}$ has been added to the text. GEOS-Chem does not directly derive ML height, it is provided from the parent meteorological fields (GEOS-FP) generated by the NASA Global Modeling and Assimilation Office. The ML high bias remains in a more direct comparison when GEOS-FP simulated backscatter profiles are fed into the same processing algorithm for the lidar measurements (Scarino et al., 2014b). The daytime ML height, which is read from the processed GEOS-FP file, was decreased by 40% to correct for this bias. This does imply that a good representation of ML height

is critical for CTM $PM_{2.5}$ applications, but does not necessarily imply that external information is necessary.

Minor

3. Abstract. Why does the model require a missing oxidant?

We elaborate on the need for a missing oxidant for sulfate in Section 2 and deleted that sentence from the abstract (it's not really a take-home message).

4. Abstract. There are statements that say GEOS-chem reproduces observed column aerosol mass with 6%, extinction within 16%, and space-based AOD within 21%. Is GEOS-chem biased higher or lower than these other measurements?

In all cases, the model is biased low – text has been adjusted to make this clearer.

5. Abstract. The abstract needs to mention the performance of GEOS-Chem related to PBL height and this impact on PM2.5.

We prefer not to. The ML bias has to do with the GEOS-FP meteorological fields, not GEOS-Chem proper. This seems like a technical issue to be covered in the text but does not rise to the level of the abstract as a take-home message for the reader.

6. Page 17659, Line 24. Should the Fischer et al., 2014 reference be 2015 instead? I would assume the Fischer reference should use SEAC4RS data.

Fischer et al. (2014) is a general reference about the need to account for fire plume buoyancy in GEOS-Chem.

7. Page 17659, line 29. Note that these are DC-8 flight tracks. It may be appropriate to note that these tracks also extend over other parts of the continental US as well as the Caribbean Sea.

Additional clarification has been added to the text.

8. Page 17662, line 19. The Scarino reference is not listed in the references.

Added to the text.

9. Page 17662, line 22. The Hair et al. reference does not indicate how the HSRL was used to derive ML heights.

See Scarino et al. (2014a), and references therein, which has been added to the reference list.

10. Page 17667, line 29. Since the model requires buoyant injection of forest fire smoke, does this mean the model requires external information to determine the height at which the smoke has been injected?

We now state in the text that we use generic injection heights for extratropical fires based on previous work.